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Soil Survey

The Middle Yellowstone Valley Area Montana

By
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and
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United States Department of Agriculture

UNITED STATES DEPARTMENT OF AGRICULTURE
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In cooperation with the
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SOIL SURVEY OF THE MIDDLE YELLOWSTONE VALLEY AREA, MONTANA

By William DeYoung, in Charge, and F. K. Nunns, Montana Agricultural Experiment Station, and L. H. Smith, Soil Survey Division, Bureau of Chemistry and Soils,[1] United States Department of Agriculture

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United States Department of Agriculture in cooperation with the Montana Agricultural Experiment Station

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AREA SURVEYED

The middle Yellowstone Valley area is in southeastern Montana and roughly parallels the course of the Yellowstone River through Treasure, Rosebud, and Custer Counties (fig. 1). The boundaries are irregular, having been drawn to include the main valley of the Yellowstone River and the lower parts of the small valleys of its tributaries. In addition, tracts of bordering uplands, benches, and slopes on either side of the valley have been included. The total area comprises 378 square miles, or 241,920 acres.

The purpose of this survey is to provide information regarding the soils of the area that are now under irrigation and those of adjoining areas that may be irrigated in the future. This information is basic to the broader study of land utilization.

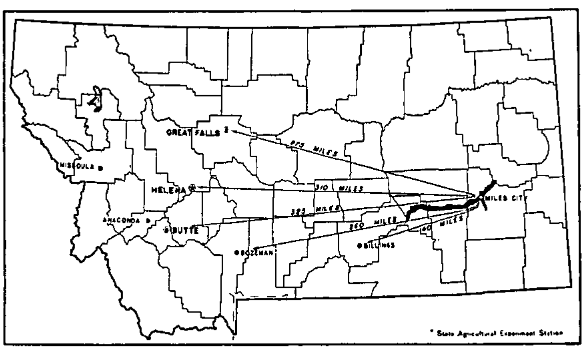

FIGURE 1.—Sketch map showing location of the Middle Yellowstone Valley area, Mont.

The area dissected by the valley

[1] The Soil Survey Division was transferred to the Bureau of Plant Industry July 1, 1939.

of the Yellowstone River is a part of the northern Great Plains, which slope eastward from the Rocky Mountains. The Yellowstone River has cut its valley in successive stages, leaving distinct benches or terraces as remains of former alluvial plains. In some localities a series of two or three terraces has formed, the highest of which generally is the largest and best developed. The most prominent high terraces bordering the valley are the three flats, which lie north of Miles City, east of Forsyth, and north of Hysham, respectively.

In a general view of the valley these benches appear level, but closer inspection shows them to be cut by stream channels and coulees bordered by narrow strips of rough land. Steep escarpments mark the descent from the high terraces to the present valley floor. Water-worn gravel underlies the terraces and in many places is left by erosion of the terrace as litter on the face of the escarpment.

Two principal geologic formations underlie the alluvium deposited by the Yellowstone River and outcrop in the bordering bluffs and rolling uplands. The Lance formation consists of alternating beds of light grayish-brown sandstones and gray fine-grained shales. The action of wind and water on these interbedded rocks, which vary greatly in their susceptibility to erosion, has resulted in irregular dissection and the carving of fantastic shapes along the cliffs and the development of areas of a badland topography. The Bearpaw formations are composed of dark-gray clay shales, which weather and erode to form characteristic rounded hills.

The lower or more recently formed alluvial bottoms of the main valley are generally flat, but the first, or lowest, terrace is crossed in places by low swales and sand or gravel bars, which indicate former overflow channels of the river.

The elevation of the valley and the fall of the Yellowstone River are shown by the elevations of the stations distributed along the Northern Pacific Railway, which parallels the river. At Bighorn, near the western edge of the area, the elevation is 2,712 feet above sea level. Eastward from Bighorn the elevation at Hysham is 2,667 feet; at Forsyth, 2,535 feet; at Miles City, 2,377 feet; and at Benz, a short distance outside of the area, the elevation is 2,289 feet. The distance by rail from Bighorn to Benz is 114 miles. The elevations of the valley benches range from 10 to 250 feet above the valley floor.

Natural drainage ranges from good to excessive, except in some depressions, in which the soil is heavy and percolation of water is extremely slow, and in places that are saturated by seepage from the bordering uplands. Under irrigation, however, natural moisture conditions have been materially changed, especially where seepage losses from irrigation canals have been heavy or where excessive use of water has produced a high water table. Isolated areas have been affected by seepage water and by the accumulation of salts. Damage from this cause has been most serious on the Tongue-Yellowstone irrigation project east of Miles City, on the Cartersville project east of Cartersville, and on the Yellowstone district project in the vicinities of Howard, Finch, and Sanders.

The native vegetation of eastern Montana is mainly a short-grass association. The dominant plants are blue grama (*Bouteloua gracilis*), bluestem or western wheatgrass (*Agropyron smithii*), needle-and-thread (*Stipa comata*), little bluestem (*Andropogon scoparius*), threadleaf sedge or niggerwool (*Carex filifolia*), junegrass (*Koeleria cristata*), and big sagebrush or black sage (*Artemisia tridentata*). Saline areas support a growth of saltgrass (*Distichlis spicata*), greasewood (*Sarcobatus vermiculatus*), and saltbush (*Atriplex argentea*).

It has been estimated that about 410 farmers are located on the irrigated land of the Yellowstone Valley extending from the mouth of the Big Horn River to the Prairie County line. The population of the area has been drawn from many sources. A few of the pioneer cattlemen, who came principally from Texas and Kansas, together with their descendants remain in the area. At a later date the homesteaders came, largely from States farther east, the greater numbers from North Dakota, South Dakota, and Minnesota. Many of the farmers on the irrigated land are of foreign birth, largely Norwegians, Germans, and Russians.

The most important towns along the Yellowstone Valley in this area are Miles City, Forsyth, and Hysham. Miles City, with a population of 7,175, according to the 1930 census, is the county seat of Custer County. It is a division point on the Chicago, Milwaukee, St. Paul & Pacific Railroad and an important trading center for the southeastern part of the State. Forsyth, with a population of 1,591, is the county seat of Rosebud County, and Hysham, having a population of 258, is the county seat of Treasure County. All the towns of the area have excellent school facilities as well as modern municipal improvements. Many religious denominations are represented with church organizations and places of worship.

Two transcontinental railroads serve the area: The Northern Pacific Railway extends throughout the area, and the Chicago, Milwaukee, St. Paul & Pacific Railroad, from Forsyth eastward. United States Highway No. 10 traverses the valley from east to west. Feeder highways are kept in fair condition throughout the year.

CLIMATE

The climate of the middle Yellowstone Valley area is characterized by moderately low annual precipitation, a dry atmosphere, hot summers, cold winters, and a large proportion of sunshiny days. During the summer the daylight ranges in length from 14 to 16 hours in every 24. The valley is subject, particularly during the winter, to the frequent sudden changes of temperature characteristic of the northern Great Plains.

Climatic data, compiled from records of the United States Weather Bureau Station at Miles City, are summarized in table 1.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Miles City, Custer County, Mont.*

[Elevation, 2,351 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1936)	Total amount for the wettest year (1879)	Snow, average depth
	°*F.*	°*F.*	°*F.*	*Inches*	*Inches*	*Inches*	*Inches*
December	21.0	64	−52	0.63	0.35	0.58	4.7
January	14.5	57	−65	.66	.58	.26	6.2
February	16.8	68	−49	.49	.40	.69	5.1
Winter	17.4	68	−65	1.78	1.33	1.53	16.0
March	28.6	88	−38	.86	.21	.28	7.2
April	44.7	90	−7	1.12	.23	2.20	1.8
May	56.7	101	17	2.24	1.12	2.75	2.1
Spring	43.3	101	−38	4.22	1.56	5.23	11.1
June	66.0	108	33	2.66	.15	5.23	0
July	72.9	112	31	1.54	1.00	5.90	0
August	71.5	112	32	1.08	.39	1.84	0
Summer	70.1	112	31	5.28	1.54	12.97	0
September	61.2	102	16	1.04	.69	.44	.1
October	46.5	94	−5	.90	.57	2.47	1.2
November	30.9	76	−26	.57	.37	.11	3.4
Fall	46.2	102	−26	2.51	1.63	3.02	4.7
Year	44.3	112	−65	13.79	6.06	22.75	31.8

The winter and summer extremes of temperature in the middle Yellowstone Valley differ greatly; the highest temperature ever recorded is 112° F. and the lowest −65°. Temperatures near these extremes are seldom reached and are of short duration. The annual mean temperature is 44.3°. The average date of the last killing frost is May 1 and that of the first is October 2, giving an average frost-free period of 154 days. In normal seasons killing frosts seldom occur after May 20 or earlier than September 20. Late spring frosts rarely damage small grains or sugar beets, but early fall frosts may damage tender garden crops and grains sown in late spring.

The annual precipitation varies considerably from year to year, as does also its distribution throughout the growing season. During wet years, such as 1906, 1915, 1916, and 1927, little irrigation was necessary, and then only for such crops as sugar beets and alfalfa; but in the dry years of 1930, 1931, and 1933 all nonirrigated crops were an almost complete failure. The average annual precipitation is 13.79 inches, but annual precipitations as low as 6.06 inches and as high as 22.75 inches have been recorded. Generally about 60 percent of the total rainfall is received between April 1 and September 1 when it is most needed by the growing crops. Generally the rainfall is heaviest during May and June. A marked deficiency of rainfall during these months results in failure for dry-land crops. July and August are the months when water for irrigation is most needed, particularly for alfalfa, sugar beets, and pastures.

Although strong winds are neither so frequent nor so severe in southeastern Montana as in some parts of the Plains area, they have

caused considerable soil drifting in the drier years, particularly in areas where the roots and other fibrous organic matter in the soil have been destroyed through cultivation. Hot winds from the south and southeast have caused serious losses to nonirrigated crops in the drier years. Local hailstorms of more or less severity occur during the summer but are no more frequent than in other parts of the Great Plains.

AGRICULTURAL HISTORY AND STATISTICS

Probably the first white man to see eastern Montana was Francis Larocque, an agent of the Northwest Fur Co., who traversed it in 1805. The Lewis and Clark Expedition traveled down the Yellowstone in 1806. According to the records of the Montana Historical Society, the first fur-trading post in Montana was established at the junction of the Big Horn and Yellowstone Rivers during the fall and winter of 1807–08.

Settlement of the area by white men began when a number of military posts were established along the Yellowstone River. Fort Keogh was established near the present site of Miles City in 1877. Settlers began to come in just before the construction of the Northern Pacific Railway, which reached this territory in 1881.

The raising of livestock was begun near the forts and trading posts and soon became an important enterprise over the entire section. In Custer County,[2] which then included a large territory in southeastern Montana, it is recorded [3] that cattle increased from 1,935 head in 1880 to more than 200,000 in 1884, and by 1886 500,000 head were on the ranges. The winter of 1886–87 was very severe, and 60 percent of the cattle were said to have been lost because of lack of protection from cold and scarcity of feed. By 1890 the number of cattle had decreased to 135,000, and these had to share the range with 100,000 sheep.

It was not until the period of 1907–17, during the so-called dry-land movement, that large numbers of farmers located in all parts of Montana. Although eastern Montana has always been considered primarily a range country, nearly all of the tillable lands, regardless of their character, were homesteaded and broken during this rush of settlers. Plowing destroyed, or at least greatly injured, the stands of native grass, and the reestablishment of a heavy grass cover with either cultivated or native grasses has been very slow.

Irrigation in both the larger and the smaller valleys was started soon after settlement, as the need for the production of hay to insure the wintering of livestock became apparent. The Rancher project near Myers was organized in 1904 to irrigate land; the Cartersville project in Rosebud County and the Yellowstone district project in Treasure and Rosebud Counties in 1909; the Tongue-Yellowstone project in Custer County in 1911, when it took over the Miles Canal & Irrigation Co.; and the Buffalo Rapids, North Sanders, Big Horn-Tullock, Box Elder, and Hammond projects in 1918 and 1919.[4]

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[2] Previous to 1877, all the Great Plains area of Montana was included in Dawson County. Custer County was created in 1877, Rosebud County in 1901, and Treasure County in 1919.

[3] MILLIGAN, M. B. HISTORY OF MONTANA COUNTIES. Montana Standard, Butte, Mont., Apr. 26, 1931.

[4] TOOTELL, R. B. AN INVENTORY OF MONTANA IRRIGATION PROJECTS. Mont. Agr. Col. Ext. (Pub.) Bul. 124, 104 pp., illus. 1932.

The Buffalo Rapids and North Sanders projects have high-water ditches, which are usable only when the Yellowstone River is high or at flood stage. The Hammond and the Box Elder districts are pumping projects—the former pumping directly from the river and the latter pumping from the Yellowstone Canal. The Big Horn-Tullock project is inoperative because of the washing out of the original dam in the Big Horn River.

The development of the various irrigation districts has been slow because of the difficulty of meeting the expense of constructing and maintaining the irrigation works. In some places heavy soil, alkali, and drainage troubles added to the expense of the enterprises. The acreages included in the various districts are given in table 2.

TABLE 2.—*Land included in irrigation projects in the middle Yellowstone Valley area, Montana* [1]

Project	Total land	Irrigated land	Project	Total land	Irrigated land
	Acres	*Acres*		*Acres*	*Acres*
Rancher	5,000	4,250	Buffalo Rapids	4,000	3,200
Tongue-Yellowstone	11,156	9,700	North Sanders	5,000	3,500
Cartersville	12,000	8,000	Box Elder	1,200	1,000
Yellowstone district	10,000	7,500			
Hammond	4,000	3,500	Total	52,356	40,650

[1] TOOTELL, R. B. See footnote 4, p. 5.

In addition to the irrigable land included in the several organized districts, several hundred acres are irrigated by a few private pumping projects located along the valley. The largest of these is near Sheffield, where about 1,200 acres are irrigated for the production of alfalfa hay and sugar beets.

From Federal census data it is impossible to determine the acreage in crops through any particular part of any one county, neither is it possible to isolate the areas privately irrigated from the dry-farmed areas. The sugar companies, however, contract their sugar-beet acreage and accurately record the harvested acreage and the tonnage. The harvested acreage for the various districts in 1931 and 1932 in the territories of two such companies is given in table 3.

TABLE 3.—*Harvested sugar-beet acreage and average acre yields for five irrigation districts in the middle Yellowstone Valley area, Montana, in 1931 and 1932*

Project	1931		1932	
	Acres	Average acre yield	Acres	Average acre yield
		Tons		*Tons*
Cartersville [1]	1,074.15	10.78	1,050.91	13.59
Hammond [1]	660.23	13.52	597.44	14.69
Tongue-Yellowstone [1]	430.67	10.24	476.42	14.81
Rancher [2]	383.00	13.08	481.00	18.36
Yellowstone [2]	1,918.00	12.11	1,973.00	14.20
Total	4,466.05	11.90	4,578.77	14.60

[1] Source: Holly Sugar Co., Sidney, Mont.
[2] Source: Great Western Sugar Co., Billings, Mont.

The 1930 Federal census does not segregate the acreages of crops grown on irrigated land from those grown without irrigation. Certain crops, however, such as corn, alfalfa, and sugar beets, are grown largely in the valley, hence it may be of interest to note in table 4 the importance of these crops in the three counties, parts of which are included in this area.

TABLE 4.—*Acreage and production of selected crops in 1929 and 1934 as reported by the Federal census for Custer, Rosebud, and Treasure Counties, Mont.*

County and year	Corn			Alfalfa				Sugar beets	
	Total	Harvested for grain		Hay		Seed			
	Acres	*Acres*	*Bushels*	*Acres*	*Tons*	*Acres*	*Bushels*	*Acres*	*Tons*
Custer County:									
1929	6,387	1,246	17,000	17,633	23,534	5,305	10,628	90	975
1934	741	89	1,417	8,054	7,426	(1)	(1)	889	6,836
Rosebud County:									
1929	8,945	2,495	26,471	24,172	28,823	10,468	18,202	1,310	11,502
1934	857	476	9,386	10,816	13,242	(1)	(1)	2,230	27,854
Treasure County:									
1929	1,913	169	2,420	6,211	8,957	8,346	13,134	1,398	13,955
1934	270	234	4,356	5,099	8,415	(1)	(1)	1,846	24,917

[1] Not reported.

Wheat, in former years, was the leading cash crop on both the dry and irrigated farms; but because of decline in prices, about two-thirds of the irrigated acreage used for wheat in 1927 was replaced by other crops during 1931. At present (1933) it is believed that wheat should be grown on irrigated land only as a part of the general rotation scheme and probably should follow an intertilled crop, such as corn, sugar beets, or beans.

Alfalfa must be regarded as the principal crop on irrigated or subirrigated land, as it is the foundation of practically all systems of farming adapted to the valley lands. Alfalfa now occupies from 20 to 50 percent of the irrigated land, depending on the types of farming on the various ranches. Considered as a crop assisting in the maintenance of soil fertility as well as providing additional hay for livestock feeding, it is very valuable. The reported yields are very low. Alfalfa seed has been an important cash crop, although the quantity produced is somewhat variable. Many farmers produce alfalfa seed under the inspection and registration regulations of the Montana Seed Growers' Association.

The growing of sweetclover, mainly as a pasture crop, now occupies a minor place in the farming system of this area.

The acreage in corn varies considerably from year to year, but corn is one of the surest and best yielding feed crops. It does best on the medium- to light-textured soils, which warm early in spring, and under irrigation good yields are obtained. A few farmers make a specialty of growing corn for seed.

An increasing acreage of barley has been grown for feed during the last few years. This crop seems to be better adapted to the heavy soils than is corn. Only a small acreage of the irrigated land is devoted to oats.

Beans are not widely grown on the irrigated land, but they are well adapted to the climate and soil conditions prevailing along the Yellowstone Valley. They fit well in the alfalfa-beet rotations as an intermediate crop.

The sugar-beet acreage in the irrigated districts has been increasing because of the relatively high cash returns per acre. The aggregate area is nearly equal to that of alfalfa. The acreage handled by an individual farmer usually is small (10 to 20 acres), although a few farmers make a specialty of this crop.

Most farmers use a small area near the homestead for the production of small fruits and garden vegetables, such as potatoes, onions, cabbage, sweet corn, cucumbers, carrots, turnips, tomatoes, cantaloups, and watermelons, all of which can be produced successfully on irrigated land.

Dry farming prevails on the higher benches and in areas adjacent to various irrigation projects. During the progress of the soil survey in 1933 it was estimated that about 12,000 acres of nonirrigated land were used for the production of grain crops, mainly wheat. A large proportion of this acreage was located on the Forsyth bench east of the town of Forsyth. The rest of the dry-land area was either idle or used only for grazing.

Until very recently the use of soil amendments, other than barnyard manure, was practically unknown. At present, however, some commercial fertilizers are used in the production of sugar beets, on the advice of the sugar companies. Superphosphate is the principal fertilizer used.

During the last few years labor has been plentiful. Formerly much of the labor in the production of sugar beets was performed by nonresidents engaged by the sugar companies; but severe drought, which seriously reduced production in the dry-farmed areas, has left many residents free to offer their services.

The size of irrigated farms differs considerably, depending on the type of farming, the tillable acreage or relief of the area concerned, and the extent of intensive farming. Where sugar beets and garden vegetables are grown the farms are small. On the Tongue-Yellowstone project the farms range from 60 to 80 acres in size; on the Cartersville project, from 80 to 160 acres; on the Hammond project, about 175 acres; on the Yellowstone district project, from 80 to 400 acres; and on the Rancher project, from 40 to 500 acres. The most common size is about 80 acres.

In the dry-farming sections the farms range from a quarter section to several sections in size, according to the tillable area and the type of farming. Since the introduction of power machinery, the number of farms in the area has decreased, with a consequent increase in size of the individual farm.

Table 5 shows the trend of farm tenure during the last 15 years in the counties named, as reported by the Federal census.

TABLE 5.—*Number and tenure of farms in Custer, Rosebud, and Treasure Counties, Mont., as reported in the Federal censuses for 1920, 1925, 1930, and 1935*

County	Year	Total	Farms operated by—					
			Owners		Tenants		Managers	
		Number	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*
Custer	1920	941	845	89.8	62	6.6	34	3.6
	1925	716	593	82.8	103	14.4	20	2.8
	1930	715	546	76.4	157	21.9	12	1.7
	1935	750	581	77.5	156	20.8	13	1.7
Rosebud	1920	1,136	1,019	89.7	88	7.7	29	2.6
	1925	792	636	80.3	147	18.6	9	1.1
	1930	940	714	76.0	208	22.1	18	1.9
	1935	1,080	866	80.2	207	19.2	7	.6
Treasure	1920	330	268	81.2	61	18.5	1	.3
	1925	299	199	66.5	98	32.8	2	.7
	1930	266	190	71.4	76	28.6	0	.0
	1935	256	173	67.6	82	32.0	1	.4

Although a few fine modern farm dwellings and other farm buildings have been erected in the area, many of the buildings are rather plain but fairly adequate for the purposes for which they are used. Most farmers have practically all types of modern machinery suited to either dry farming or irrigation farming as their land demands. Since the use of the tractor has become general the number of horses has been reduced considerably.

All eastern Montana and the area contiguous to the Yellowstone Valley has been considered primarily a range country. In the early days large cattle outfits controlled the territory. Cattle did not share the range with sheep for a number of years. With the settlement of the dry lands, most of the large livestock companies gradually dissolved and were replaced by many smaller livestock ranches and grain farms. The relationship between the income derived from livestock and from crops has been changing during the last 25 years, but the raising and fattening of livestock is still a very important enterprise in this area. Much of the hay and grain grown on the irrigated land is fed on the farm to cattle and sheep raised on nearby ranches. The value of livestock products sold or traded as compared with the value of crops is given in table 6, data for which are taken from the 1930 census.

TABLE 6.—*Value of agricultural and livestock products in Custer, Rosebud, and Treasure Counties, Mont., in 1929, as reported by the Federal census*

Product	Custer County	Rosebud County	Treasure County
Agricultural products:			
Cereals	$361,458	$446,127	$166,217
Other grains and seeds	235,679	291,317	184,159
Hay and forage	469,667	489,758	123,599
All vegetables and potatoes	110,045	97,830	14,601
Fruits	2,129	1,237	1,792
All other field crops	7,313	86,265	104,663
Forest products cut on farms	17,724	14,921	14,298
Livestock products:			
Dairy products sold	143,125	99,141	34,256
Wool shorn	175,170	385,456	4,516
Poultry products produced	123,099	131,577	38,984
Honey produced	82	5,194	304
Total	1,645,491	2,048,823	687,389

Table 7, compiled from Federal census data for 1930, shows the number of farms by type for each of the three counties.

TABLE 7.—*Number of farms, by type,*[1] *in Custer, Rosebud, and Treasure Counties, Mont., as reported by the 1930 Federal census*

Type of farm	Custer County	Rosebud County	Treasure County	Type of farm	Custer County	Rosebud County	Treasure County
General	91	154	49	Self-sufficing	11	54	3
Cash-grain	179	184	61	Truck	7	5	----------
Crop-specialty	98	150	89	Abnormal	31	37	5
Dairy	31	13	----------	Unclassified	40	36	17
Animal-specialty	17	55	----------				
Livestock-ranch	208	252	42	Total	715	940	266
Poultry	2	----------	----------				

[1] Classification on basis of 40 percent or more of the total value of all products of the farm coming from the source indicated.

At present sheep far outnumber cattle and are the most important class of livestock kept on most farms. Many lambs are shipped out in the fall to Middle Western feed lots. Each year sheep from the ranges are brought into the valley for wintering.

The first settlers engaged in cattle ranching, and animals were raised, for the most part, to supply Middle Western feeders. The present trend is to finish more young cattle locally, particularly since feeds, such as corn and alfalfa, can be produced in abundance on the irrigated land.

Hogs are common on most of the irrigated farms, and many hogs are raised on the dairy farms. The number has steadily increased in recent years. The principal hog feeds are wheat, barley, or corn, supplemented with skim milk and pasture.

The number and value of livestock in the three counties for the years 1920, 1930, and 1935 are given in table 8.

TABLE 8.—*Number and value*[1] *of livestock in Custer, Rosebud, and Treasure Counties, Mont., in 1920, 1930, and 1935*

County and year	Horses		Cattle		Sheep		Swine		Chickens	
	Number	*Value*	*Number*	*Value*	*Number*	*Value*	*Number*	*Value*	*Number*	*Value*
Custer County:										
1935	6, 664	--------	19, 371	----------	46, 979	---------	735	-------	25, 623	------
1930	14, 123	$302, 258	42, 292	$2, 463, 497	75, 310	$630, 928	2, 185	$28, 446	34, 489	$23, 453
1920	18, 601	917, 515	30, 476	1, 768, 583	28, 607	377, 120	1, 947	34, 842	[2] 29,187	[2] 31,140
Rosebud County:										
1935	10, 013	--------	31, 815	----------	98, 804	---------	1, 136	-------	25, 819	------
1930	19, 707	421, 022	33, 603	1, 864, 364	156, 145	1, 300, 380	2, 740	35, 759	39, 235	26, 680
1920	24, 702	978, 697	51, 599	3, 041, 610	92, 987	1, 110, 066	3, 368	49, 418	[2] 37,956	[2] 36,503
Treasure County:										
1935	2, 038	--------	10, 177	----------	15, 910	---------	565	-------	9, 641	------
1930	3, 243	76, 507	9, 105	473, 577	7, 511	60, 847	903	10, 204	11, 264	8, 223
1920	4, 076	254, 580	7, 161	382, 200	8, 882	107, 723	1, 196	18, 534	[2] 13,253	[2] 9, 624

[1] Values not reported in 1935. [2] All poultry.

Dairy and poultry products and the production of wool are increasing as sources of income. Dairying has been of little commercial importance in years past, but the number of dairy cattle has been increasing on the irrigated land where large quantities of alfalfa hay and feed grains can be produced. The natural resources are ex-

cellent, but the distance of this area from large consuming centers limits the market for dairy products. Nearly all of the farms maintain a flock of poultry for supplying the farmer's family with poultry and eggs. Any surplus is used in trade for groceries. Data indicating the importance of these livestock products for 1929, together with such comparable data as were reported by the Federal census of 1935 for 1934, are presented in table 9.

TABLE 9.—*Livestock products of Custer, Rosebud, and Treasure Counties, Mont., for 1929 and 1934*

County and year	Cows and dairy products							Sheep and wool			Chickens and chicken eggs							
	Cows milked		Milk produced	Whole milk sold		Butterfat sold		Sheep shorn		Wool shorn	Chickens raised		Chickens sold alive or dressed		Eggs produced		Eggs sold	
	Farms reporting	Total		Farms reporting	Quantity	Farms reporting	Quantity	Farms reporting	Total		Farms reporting	Total	Farms reporting	Total	Farms reporting	Quantity	Farms reporting	Quantity
	Number	*Number*	*Gallons*	*Number*	*Gallons*	*Number*	*Pounds*	*Number*	*Number*	*Pounds*	*Number*	*Number*	*Number*	*Number*	*Number*	*Dozen*	*Number*	*Dozen*
Custer County:																		
1929	509	2,340	1,110,957	51	237,163	220	130,384	126	62,046	547,406	562	67,060	242	17,467	--------	256,606	332	122,698
1934	512	2,024	651,068	--------	--------	--------	--------	112	69,433	632,319	514	41,725	--------	--------	550	178,090	--------	--------
Rosebud County:																		
1929	636	2,769	1,177,051	26	35,369	267	177,715	175	124,323	1,204,549	689	65,814	243	14,883	--------	287,127	365	123,923
1934	584	2,182	712,208	--------	--------	--------	--------	162	126,053	1,124,228	563	40,198	--------	--------	644	176,893	--------	--------
Treasure County:																		
1929	204	878	369,434	15	17,826	117	67,208	21	1,566	14,569	218	20,409	92	6,529	--------	83,556	125	40,656
1934	188	691	234,120	--------	--------	--------	--------	42	13,865	129,258	181	13,701	--------	--------	200	64,733	--------	--------

SOIL-SURVEY METHODS AND DEFINITIONS

Soil surveying consists of the examination, classification, and mapping of soils in the field.

The soils are examined systematically in many locations. Test pits are dug, borings are made, and exposures, such as those in road or railroad cuts, are studied. Each excavation exposes a series of distinct soil layers, or horizons, called, collectively, the soil profile. Each horizon of the soil, as well as the parent material beneath the soil, is studied in detail; and the color, structure, porosity, consistence, texture, and content of organic matter, roots, gravel, and stone are noted. The reaction of the soil [5] and its content of lime and salts are determined by simple tests.[6] Drainage, both internal and external, and other external features, such as relief, or lay of the land, are taken into consideration, and the interrelation of soils and vegetation is studied.

The soils are classified according to their characteristics, both internal and external, special emphasis being given to those features influencing the adaptation of the land for the growing of crop plants, grasses, and trees. On the basis of these characteristics soils are grouped into mapping units. The three principal ones are (1) series, (2) type, and (3) phase. In places two or more of these principal units may be in such intimate or mixed pattern that they cannot be clearly shown separately on a map, but must be mapped as (4) a complex. Areas of land, such as coastal beach or bare rocky mountainsides that have no true soil, are called (5) miscellaneous land types.

The most important group is the series, which includes soils having the same genetic horizons, similar in their important characteristics and arrangement in the soil profile, and developed from a particular type of parent material. Thus, the series includes soils having essentially the same color, structure, and other important internal characteristics and the same natural drainage conditions and range in relief. The texture of the upper part of the soil, including that commonly plowed, may vary within a series. The soil series are given names of places or geographic features near which they were first found. Thus, Havre, Beaverton, and Patent are names of important soil series in this area.

Within a soil series are one or more soil types, defined according to the texture of the upper part of the soil. Thus, the class name of the soil texture, such as sand, loamy sand, sandy loam, loam, silt loam, clay loam, silty clay loam, and clay, is added to the series name to give the complete name of the soil type. For example, Havre very fine sandy loam and Havre silt loam are soil types within the Havre series. Except for the texture of the surface soil, these soil types have approximately the same internal and external characteristics. The soil type is the principal unit of mapping, and because of its specific character it is usually the soil unit to which agronomic data are definitely related.

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[5] The reaction of the soil is its degree of acidity or alkalinity expressed mathematically as the pH value. A pH value of 7 indicates precise neutrality, higher values indicate alkalinity, and lower values indicate acidity.

[6] The total content of readily soluble salts is determined by the use of the electrolytic bridge. Phenolphthalein solution is used to detect a strong alkaline reaction.

A phase of a soil type is a variation within the type, which differs from the type in some minor soil characteristic that may have practical significance. Differences in relief, stoniness, and the degree of accelerated erosion are frequently shown as phases. For example, within the normal range of relief for a soil type, there may be areas that are adapted to the use of machinery and the growth of cultivated crops and others that are not. Even though there may be no important difference in the soil itself or in its capability for the growth of native vegetation throughout the range in relief, there may be important differences in respect to the growth of cultivated crops. In such an instance the more sloping parts of the soil type may be segregated on the map as a sloping or a hilly phase. Similarly, soils having differences in stoniness may be mapped as phases, even though these differences are not reflected in the character of the soil or in the growth of native plants.

The soil surveyor makes a map of the county or area, showing the location of each of the soil types, phases, complexes, and miscellaneous land types, in relation to roads, houses, streams, lakes, section and township lines, and other cultural and natural features of the landscape.

SOILS AND CROPS

The soil survey of the middle Yellowstone Valley area, for the most part, covers the valley bottoms and benches, as well as the slopes adjacent to or lower than the irrigation canals. Some of the bordering uplands and slopes are included to make the area continuous and more regular in shape. The irrigated valley may be considered as a section of diversified farming, when compared with other parts of the State. The low altitude and favorable climatic factors give this irrigated area advantages over higher sections in the variety of crops that it is possible to grow.

The cropping practices of the area depend to a large extent on the location, or the lay of the land, which determines its irrigability and drainage, as well as on the character of the soils. The dry-farmed soils of the valley are limited to the production of crops that withstand drought well, such as grains and native grasses.

The soils of the higher benches have developed distinct soil layers, or horizons. The porous surface soil allows ready penetration of rainfall, and the relatively heavy textured subsoil provides good moisture-holding capacity. As a result of this profile development, these soils ordinarily produce better crops under fallowing and other dry-farming practices than the younger porous soils of the lower terraces or bottoms, which are not retentive of moisture. The porosity of most of the soils of the bottoms and low terraces, on the other hand, is a favorable factor under irrigation, as this characteristic allows excellent drainage, thus preventing to a large extent the seepage and accumulation of salts associated with irrigation in many places. Some of the soils of the bottoms, however, have a heavy texture, which obstructs drainage, and an unfavorable physical condition, which makes cultivation under dry-farming practices impracticable.

On the bases of relief, accessibility, and suitability of the land for farming under irrigation, the soils of the area may be classified roughly into four groups, as follows: (1) Soils of the valley bot-

toms; (2) soils of the valley benches and gentle slopes; (3) soils of the eroded slopes; and (4) miscellaneous soils and land types. In subsequent pages of this report the soils of the middle Yellowstone Valley area are described in detail in relation to their individual characteristics, limitations, and adaptations for the production of the various crops suited to the section. Their locations are indicated on the soil map, and their acreage and proportionate extent are given in table 10.

TABLE 10.—*Acreage and proportionate extent of the soils mapped in the middle Yellowstone Valley area, Montana*

Soil type	Acres	Percent	Soil type	Acres	Percent
Havre very fine sandy loam	43,904	18.1	Huff silty clay loam	7,360	3.1
Havre silt loam	14,720	6.1	Patent clay loam	4,608	1.9
Havre silty clay loam	8,960	3.7	Patent silty clay loam	2,368	1.0
Banks fine sand	19,328	7.9	Patent silt loam	10,176	4.2
Harlem clay	4,992	2.0	Flasher fine sandy loam	1,280	.5
Bowdoin clay	12,416	5.1	Bainville silty clay loam	1,152	.5
Bowdoin silty clay loam	512	.2	Rough broken land	62,592	25.9
Beaverton very fine sandy loam	10,240	4.2	Riverwash	16,128	6.7
Beaverton loam	1,216	.5	Colluvial soils, undifferentiated	1,408	.6
Beaverton-Farland clay loams	10,048	4.2	Alluvial soils, undifferentiated	832	.4
Farland very fine sandy loam	3,008	1.3			
Huff very fine sandy loam	4,672	1.9	Total	241,920	

SOILS OF THE VALLEY BOTTOMS

The soils of the valley bottoms, which are members of the Havre, Banks, Harlem, and Bowdoin series, are important because of their capacity to produce crops under irrigation. The Havre soils—the most important agriculturally—are young and have accumulated only a small quantity of organic matter. They require a rotation that includes a legume crop in order to increase their nitrogen content. Most of the crops adapted to the area may be arranged in a suitable rotation to meet these requirements. Considered as to ease of management, durability, and productivity, Havre silt loam probably is the most desirable Havre soil. In this area the more extensive Havre soils have a very fine sandy loam texture and require slightly more irrigation water than heavier textured soils. They respond favorably to the application of manures and phosphates.

Banks fine sand is the youngest and most immature soil in the valley bottoms. It occupies two typical positions, (1) adjacent to the Yellowstone River, and (2) on the islands of the river. Only a very thin layer of soil is developed over the underlying incoherent sands and gravels. The organic-matter content is slight, and internal drainage is excessive. Only a small acreage of this soil is farmed, because of its low natural fertility, its considerable requirement of irrigation water, and the leveling necessary before cultivation is possible. The Banks soil also requires a rotation containing legumes in order that the nitrogen content may be increased. Most of this soil is utilized at present for the virgin pasturage it affords. Most of it is covered by forest or brush, and the areas are dissected by numerous high-water channels. Dry farming is not attempted on this soil because of its droughty character.

The Bowdoin soils, which consist largely of heavy clays, are locally known as gumbo soils. Their heavy texture and the generally low position with respect to the surrounding land are conducive to poor surface and internal drainage. In some areas the salt content is sufficient to interfere with plant growth and the natural vegetation is chiefly greasewood. The chief crops that can be satisfactorily grown on these soils are hay and grain.

The Harlem soil differs from the Bowdoin soils in having a lighter textured subsoil, and from the Havre soils in having a darker colored surface soil. In general, this soil is somewhat more productive than the Bowdoin soils. Alfalfa, bluejoint, and small grain are the principal crops grown.

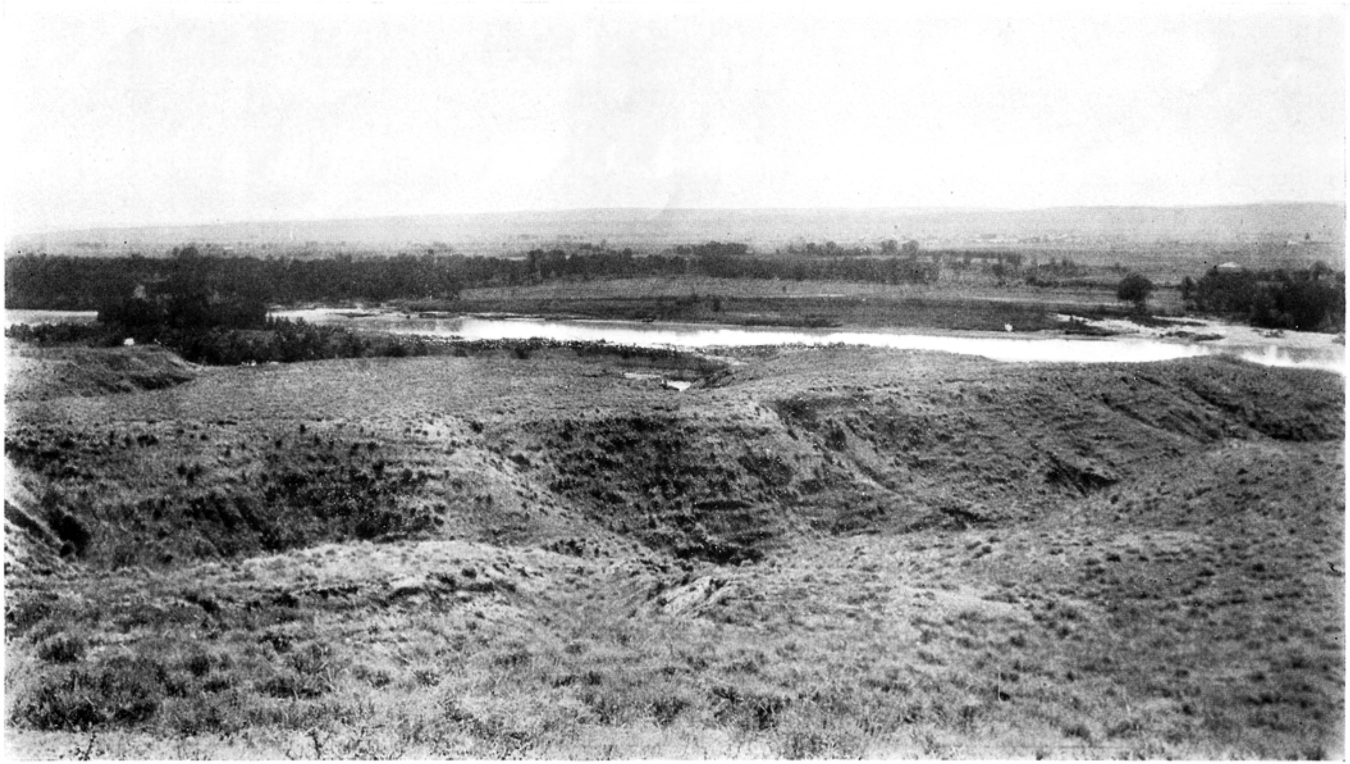
Havre very fine sandy loam.—Havre very fine sandy loam occurs in nearly all parts of the Yellowstone Valley (pl. 1, *A*). The surface soil, to a depth ranging from 6 to 9 inches, is grayish-brown or light grayish-brown very fine sandy loam. In undisturbed areas a thin faintly laminated mulch is common. In most places the soil is friable and calcareous at or near the surface. The upper part of the subsoil, which extends to a depth ranging from 20 to 30 inches, is calcareous coherent very fine sand or fine sand, which in places contains thin silty strata. The lower part of the subsoil consists of loose incoherent sand and gravel.

A soil of this character is easily leveled for irrigation farming. The surface layer is friable, it contains no gravel to interfere with plowing or cultivation, and its porous character allows moisture to percolate readily to the lower depths. As the soil material is porous and well drained throughout, it warms early in the spring.

Some areas of this soil have become affected by an accumulation of salts, owing in most places to seepage from higher land, which causes a rising water table. Adequate drainage or lowering of the water table will reclaim these areas. Where not affected by appreciable quantities of salts, this soil has excellent physical characteristics and is well suited to the growing of all crops common to the section. It is especially desirable for the production of such crops as alfalfa, sugar beets (pl. 1, *B*), beans, and potatoes. Rotations are established around the two most important crops, alfalfa and sugar beets. Although the organic matter and nitrogen content are not high, the soil may be built up easily and quickly by applying barnyard manure, and growing legumes. The use of superphosphate fertilizers for sugar beets and alfalfa, which started during the last 2 or 3 years, increases yields considerably.

Havre silt loam.—Havre silt loam is an important irrigated soil but is much less extensive than Havre very fine sandy loam. Areas of this soil occur in places where the valley widens and the stream has deposited silty materials. The surface soil ranges in color from grayish brown to brown and in texture from mellow silt loam to heavy silt loam. The darker color generally is associated with the heavier texture. A slight mulch of very fine sandy loam covers the surface of the undisturbed soil. The thickness of the silty surface material varies greatly but averages about 9 inches. A faint prismatic structure appears in the lower part of the surface soil. The surface soil grades into light-brown or gray very fine sandy loam or very fine sand. Incoherent sand or gravel underlies the soil at a depth

A, Farmstead bordering the Yellowstone River, showing Havre very fine sandy loam in foreground, riverwash in forested area across the river, and rough broken land in background; *B*, sugar beets on Havre very fine sandy loam on the Cartersville project.



Rough broken land bordering the Yellowstone River.

ranging from 2 to 3 feet. In most places this soil is only mildly calcareous at or near the surface, and, although calcium carbonate (lime) is fairly well distributed, the subsoil seems to be more calcareous than the surface soil. A few areas are affected by an accumulation of salts, and ditches may be necessary to intercept the flow of underground water and also to lower the water table.

The crop adaptations and methods of tillage and handling are similar to those of Havre very fine sandy loam. Generally speaking, Havre silt loam is a somewhat stronger soil than Havre very fine sandy loam, but superphosphate applied to this soil has given good returns in the production of sugar beets.

Havre silty clay loam.—Havre silty clay loam is the heaviest member of the Havre series in this area and is one of the medium-heavy soils of the valley. Areas of this soil are scattered over nearly all parts of the valley, generally occupying a somewhat lower position than the surrounding land. Several areas are northeast of Miles City.

The surface soil is moderately dark brown or brown silty clay loam. It is darker than the corresponding layer of the silt loam or very fine sandy loam members of the Havre series. The thickness of the surface soil ranges from 6 to 18 inches. This layer generally is faintly prismatic, fragmental, and slightly calcareous. The heavy surface layer is underlain by stratified silts and very fine sands, which continue to a depth ranging from 20 to 30 inches. The lower part of the subsoil is gray calcareous very fine sand. The soil is modified in places by sediments washed from the badland breaks bordering the valley.

In places where Havre silty clay loam borders Bowdoin clay, its texture approaches a clay and the depth to the sandy substratum generally is greater. The lower lying areas are subject to seepage and the possible accumulation of salts.

This soil is inherently very fertile and, where fairly well drained, produces excellent crops of alfalfa and sugar beets. High yields of barley and oats also are obtained. The more saline areas support a growth of greasewood and saltgrass.

Banks fine sand.—Banks fine sand is a shallow very immature soil, most areas of which lie adjacent to the Yellowstone River or on the islands in the river. The surface soil is light grayish-brown fine sand or very fine sand, and in few places is more than 3 inches thick. It contains but little organic matter and is weakly calcareous. The surface soil is underlain by loose gray feebly calcareous fine sand which grades into sand or gravel below a depth of 12 inches.

This soil is managed easily, but its natural fertility is low. Only a small proportion of it is cultivated, and average yields are low. Improvement of the fertility requires a crop rotation containing some legume. Applications of phosphates and manure bring responses and are commonly made, especially where sugar beets are grown. On account of the porous character of the lower layers, this soil requires more than normal quantities of water for irrigation. It is expensive to bring this soil into production because its undulating surface must be leveled before efficient irrigation is possible.

Several areas of this soil that are forested and dissected have a different value and land use. Although covered with trees and brush,

these areas are severely dissected by numerous high-water channels. The soil profile, however, is not essentially different from that of the other areas of Banks fine sand. To bring this soil into production, its forest cover must be removed and much leveling must be done. Land values at some future time may justify the expense of preparing these forested bottoms for crop production, but at present it is best to use the land for pasture and forestry.

Harlem clay.—Harlem clay occupies several isolated areas throughout the valley, the largest lying west of Hathaway and north of Sanders. West of Hathaway the 8-inch surface layer consists of very dark gray massive clay, which is slightly calcareous. Below this and continuing to a depth of 26 inches, the soil material is olive-gray plastic slightly calcareous clay. Below a depth of 26 inches the subsoil is brown calcareous very fine sandy loam. In some areas the sandy subsoil lies at a depth of only 10 or 12 inches.

Although many areas of this soil occupy rather low positions, it is not so salty as are the Bowdoin soils and in general is more productive. Bluejoint and alfalfa for hay are the principal crops grown. Because of its heavy character, this soil is seldom plowed.

Bowdoin clay.—Bowdoin clay is the heaviest and probably the most difficult soil to manage in this area. The surface soil is dark-gray or olive-gray intractable massive clay containing a large percentage of colloid. The soil is mildly calcareous from the surface downward. Below a depth of 12 inches the subsoil is olive-gray or brown intractable clay.. In most areas specks of white salts are noticeable at a depth of 18 or 20 inches.

The largest body of this soil is near Sanders on the north side of the valley. In this area the dominant vegetation is greasewood, a typical indicator of rather concentrated accumulations of salts. Scattered areas northeast of Miles City also are covered with greasewood. Smaller areas occur throughout the valley.

The greater part of this land never has been cultivated. At present only those areas that are favorably located with respect to surface drainage and the absence of salt accumulation are farmed. Many areas occupy basinlike depressions, which act as natural reservoirs to collect water from excessive irrigation, seepage, or rainfall. Their low position, together with the comparative impermeability of the soil, makes the land difficult to drain. The soil remains wet and cold after the surrounding land is ready to be cultivated. Such areas are best suited to the production of native grasses, such as bluestem (western wheatgrass). The better drained areas, after a considerable time under careful management, produce fair yields of alfalfa and small grains. Legumes and manures gradually improve the poor physical condition of this soil.

Bowdoin silty clay loam.—A few small areas of Bowdoin silty clay loam occur in the lower bottoms of the Yellowstone River, principally near Miles City. The surface soil is silty clay loam of the slate-gray or olive-gray color that is characteristic of the Bowdoin soils. Below a depth of about 12 inches, the soil generally is underlain by silty clay loam, but in places this layer is clay. The color is olive gray similar to or slightly lighter than that of the surface soil. Bowdoin silty clay loam is similar in most characteristics to Bowdoin clay and differs from that soil only in the slightly lighter texture, which is caused by an admixture of silty or sandy sediments.

Nearly all of the area near Kircher School, 3 miles northeast of Miles City, which has a good location and is well drained, is farmed. Elsewhere, the soil is wholly or in part poorly drained and salts accumulate in the lower parts.

SOILS OF THE VALLEY BENCHES AND GENTLE SLOPES

The benches or terraces of the Yellowstone Valley are former floors of old alluvial plains. As the river lowered its channel, new successive valley floors were established. The various benches rise above the valley floor to heights ranging from 10 to more than 250 feet. Most of these benches are nearly level and have been subjected to the forces of weathering and soil development so long that, except in the very heavy textured soils, distinct layering of the soil has developed. The soils of the valley benches and gentle slopes are members of the Beaverton, Farland, Huff, and Patent series.

The Beaverton soils are characterized by a moderately dark grayish-brown surface soil, somewhat heavier subsurface layer, a zone of concentrated lime, and a distinct gravel substratum. The texture of the surface soils ranges from very fine sandy loam to clay loam. Where irrigated, these soils are suited for growing most of the crops of the section. Nonirrigated areas are used mainly for the production of small grains and corn or for native pasture.

The surface layers of the Farland soils resemble those of the Beaverton soils except for a slightly darker brown color and greater depth to the underlying layer of lime accumulation. The soil profile of the Farland soils differs also from that of the Beaverton soils mainly in having lower layers of fine material instead of a gravelly substratum. Members of the two series are managed in a similar way.

The Huff soils are immature and lack the definite lime concentration and soil layering that the Farland and Beaverton soils possess. They are friable, light grayish brown, and free from gravel. The lower layers and parent material are sandy. The Huff soils are well adapted to irrigation farming and are suited to the production of any of the crops ordinarily grown. At the point of contact with the Farland soils, little difference can be seen on the surface, but a change from older to younger sandy parent materials gives the characteristic feature of the Huff soils to the underlying layers.

The Patent soils are developed on long gentle slopes. The parent material consists of colluvial-alluvial sediments brought down from areas of shale. These soils are dark gray and show little or no development of a profile. Some areas are affected by salts, as is shown by the dominance of the saline plant *Atriplex argentea*. These soils remain largely in their native state and are utilized only for grazing.

Beaverton very fine sandy loam.—Beaverton very fine sandy loam is a dark grayish-brown or brown soil distributed along the benches throughout the area. The undisturbed 4- or 5-inch surface layer is dark grayish-brown or brown laminated very fine sandy loam. The underlying layer, about 1 foot thick, is brown faintly prismatic noncalcareous loam. Below this layer and continuing to a depth ranging from 12 to 36 inches is a fine sandy loam that is light gray or almost white, owing to a high concentration of lime. The soil layers are

underlain by beds of gravel and sand, either loose or slightly cemented with lime.

The variation in the depth to gravel gives a wide range in the value of this soil for dry farming. Only where the gravel stratum is at the greater depth can the soil be used for dry farming, but the areas of shallower soil may be excellent for farming under irrigation. Most of this soil, however, lies well above the present levels of irrigation. Under dry farming, wheat is the chief crop. Some small grains and corn also are grown.

Beaverton loam.—Beaverton loam is similar in most characteristics to Beaverton very fine sandy loam, with which it is associated, but it has a slightly higher content of clay. In undisturbed areas the surface is covered by a 2- or 3-inch moderately dark grayish-brown very fine sandy loam mulch. The underlying soil layer, which is about 10 inches thick, consists of rich dark-brown noncalcareous loam with a well-developed prismatic structure. Below this is a layer of light grayish-brown or nearly white fine sandy loam, which is the zone of lime concentration. This layer ranges in thickness from 8 to 12 inches. The substratum consists of layers of loose sand and gravel.

Beaverton loam covers a small total area. The largest development begins about 3½ miles east of Forsyth. This soil occupies the higher benches, and drainage is good to excessive.

The value of Beaverton loam for dry farming depends on the depth of the soil over the gravel, which varies considerably from place to place. In general, this soil is more productive than Beaverton very fine sandy loam.

Beaverton-Farland clay loams.—Areas of the complex—Beaverton-Farland clay loams—are mapped on the borders of the high alluvial bench north of the Yellowstone River where lobes of the bench project into the area at several points. Large bodies are north of Myers and Hysham, and smaller ones lie to the east as far as the area north of Forsyth.

The character of the soils in the larger areas differs greatly from place to place, but the dominant soils are Beaverton clay loam and Farland clay loam. The surface soil everywhere is underlain by gravel at a depth ranging from 16 inches to more than 3 feet. The fine soil over the gravel becomes gradually thicker as it approaches the clayey uplands. It is believed that the increase in thickness of fine soil near the uplands is due to the deposition of sediments washed down from higher levels of the uplands.

The thinner soil near the edge of the terrace overlooking the valley is typical Beaverton clay loam. Here the upper 2-inch layer consists of a dark grayish-brown clay loam mulch. This is underlain by a 5-inch layer of dark grayish-brown clay loam having a prismatic structure. The color in many places has a slight olive tinge. The next lower layer, which reaches a depth ranging from 12 to 16 inches, is brown heavy clay with a slight olive tinge. This material has no definite structure. Small gravel is present in many places in this layer, and the quantity increases with depth. The zone of lime accumulation, which is the next lower layer, consists of light grayish-brown silty clay loam containing more or less rounded gravel. This layer is underlain, at a depth ranging from 18 to 36 inches, by a bed of gravel, either loose or slightly cemented by lime.

On the deeper soil materials on the terrace north of Myers and over the greater part of the terrace north of Forsyth, a soil very similar to Farland clay loam has developed. The separation of the Beaverton and the Farland soils on these benches is based mainly on the thickness of the soil layers over the gravel. As the thickness varies from place to place within short distances, no attempt is made to separate the two soils on the map.

These benches lie well above the irrigation ditches, and the land is dry farmed. The soil is naturally as well suited for dry farming as the better upland soils of this part of the State. Beaverton clay loam of this complex is deeper and more productive than the greater part of the Beaverton soils elsewhere. The Farland soil on the high terraces is as productive as the Farland soils of the lower benches. The area north of Forsyth is especially productive.

Farland very fine sandy loam.—Farland very fine sandy loam occupies well-drained alluvial benches or terraces. In cultivated areas the surface soil is dark-brown very fine sandy loam. Where the land has never been plowed, the upper 2-inch mulchlike layer is dark grayish-brown laminated very fine sandy loam. This mulch is underlain by dark grayish-brown very fine sandy loam, which is heavier in texture than the surface layer and has an indistinct prismatic structure. Below a depth of 10 inches the color becomes lighter, grading into light grayish brown or olive gray, but the texture continues to be very fine sandy loam. The material of this layer is calcareous and shows no definite structure. Below a depth of 20 inches is the olive-drab calcareous silt loam substratum.

Farland very fine sandy loam covers several small bodies on nearly flat terraces in the eastern half of the area. The level surface and the character of the soil favor farming under irrigation, but most of the areas of this soil are too high above the streams to be included in irrigation districts. Alfalfa, sugar beets, and small grains are the principal crops grown under irrigation. Land above the irrigation ditches is used either for growing wheat under dry-farming practices or for pasture.

Huff very fine sandy loam.—Huff very fine sandy loam occurs in several areas within a distance of 26 miles between Armells Creek and the town of Myers. A 1-inch layer of grayish-brown sandy mulch covers the surface. The mulch is underlain by grayish-brown friable noncalcareous very fine sandy loam ranging in thickness from 4 to 6 inches. The upper part is weakly laminated, but most of the layer is structureless. Succeeding layers, or horizons, consist of gray calcareous very fine sandy loam and sand, which in many places are interspersed with thin strata of silt.

Huff very fine sandy loam is well adapted to farming under irrigation, because it is naturally well drained and maintains an excellent physical condition. Like most of the soils in the area, it is rather deficient in nitrogen and benefits from the growing of legumes. It is a responsive soil and is suited to any of the crops commonly grown.

Small included areas, in which the surface soil approaches a loam, are suited for farming under irrigation, owing to their favorable relief and the character of the soil material. In such areas a brown sandy mulch constitutes the 2-inch surface layer, and this rests on

light grayish-brown weakly laminated noncalcareous loam, about 3 inches thick. Below this, and continuing to a depth of 10 inches, the soil is light grayish-brown friable noncalcareous very faintly prismatic loam or silt loam. The underlying layers are composed of yellowish-gray friable calcareous fine sandy loam and sand. In a few places calcium carbonate occurs at a greater depth than it does in the profile described above. This included soil produces good yields of alfalfa and sugar beets.

Huff silty clay loam.—Huff silty clay loam is the heaviest member of the Huff series mapped in this area. The bodies are scattered along the valley south of the Yellowstone River, beginning 6 miles west of Forsyth. Two very large areas are near Hysham.

The 2-inch surface layer consists of a grayish-brown noncalcareous silt loam mulch. Underlying the mulch is a 3-inch layer of laminated noncalcareous grayish-brown silty clay loam. Between depths of 5 and 8 inches, the material is faintly granular silty clay loam, slightly calcareous, friable, and somewhat lighter colored than the laminated layer. Below this, the soil becomes grayish yellow and continues friable and calcareous with no appreciable structure. The texture grades with depth from silt loam to sand.

Despite its rather heavy texture, this soil is not particularly difficult to manage. Under irrigation it produces good yields of sugar beets and alfalfa. The tilth and productivity are improved by the application of manures and the growing of legumes. The relief is favorable for irrigation.

Patent clay loam.—Patent clay loam occurs in scattered bodies from one end of the area to the other. The following description of a profile, as observed in the SW¼NE¼ sec. 21, T. 10 N., R. 49 E., is considered representative of this soil. The 6-inch surface layer is dark-gray or dark grayish-brown slightly calcareous and somewhat massive clay loam. It is underlain to a depth of 30 inches by grayish-brown only slightly calcareous clay containing numerous white salt crystals. The subsoil is calcareous gray clay mottled similarly to the layer above. The lower part of the subsoil is variable in that layers of very fine sand occur in places at different depths. This soil occupies gentle slopes and extends, in places, for some distance over alluvial flats. The parent material consists of colluvial-alluvial sediments derived from weathered shale.

The natural vegetation includes a thin growth of wheatgrass, big sagebrush (black sage), and the saltbush identified as *Atriplex argentea.* Much of this soil remains in its native state, as little success has been obtained with it in dry farming. The value of this soil for farming under irrigation is necessarily low, because its intractable character, slow internal drainage, and salt concentrations present difficult problems. Artificial drainage, manures, legumes, and persistent good management have been known to bring such soils slowly into satisfactory production.

Patent silty clay loam.—Patent silty clay loam is developed from parent material similar to that of Patent clay loam, but it generally occupies the higher slopes that border the uplands. The profile of this soil differs from that of Patent clay loam in that it has a more friable surface layer of silty clay loam texture and is more porous. Because of fairly good drainage, alkali salts are present in compara-

tively small quantities and are well distributed. Most of this soil is still in its virgin condition. The natural vegetation consists of a scant growth of *Atriplex argentea* and a dominating growth of wheatgrass and sagebrush. To less extent, use of the land involves the same problems that are associated with Patent clay loam.

Patent silt loam.—Patent silt loam occurs on the valley slopes in association with Patent silty clay loam and in many areas is adjacent to it. The topmost 6- or 7-inch layer is brown or olive-brown granular heavy noncalcareous silt loam. Below this and continuing to a depth of 20 inches, is grayish-brown cloddy calcareous silty clay loam. The underlying material is variable; in some places it is brown very fine sandy loam or sandy loam, and in other places it is dark-gray silt loam or silty clay loam.

Where this soil can be irrigated, fair crops of alfalfa and small grains are obtained. Unirrigated areas remain largely in native vegetation of big sagebrush, pricklypear, and a thin growth of wheatgrass. Attempts at dry farming have not been successful.

SOILS OF THE ERODED SLOPES

The soils of the eroded slopes occupy a few small areas between the valley benches and the broken uplands. Layers are not distinct in these young soils, little organic matter has accumulated, and many characteristics of the parent material are retained. This group includes Flasher fine sandy loam and Bainville silty clay loam.

Flasher fine sandy loam.—Flasher fine sandy loam occupies a few small scattered areas northwest and northeast of Forsyth and north of Myers. The 4- or 5-inch surface soil is brown laminated calcareous fine sandy loam. Below this and extending to a depth of 12 or 14 inches below the surface is yellowish-brown slightly calcareous fine sand. The subsoil is yellow fine sand consisting of very recently distintegrated sandstone. The depth of the developed soil material is variable. West of Hysham this soil is partly under cultivation, but in other areas it remains in its native state. The soil is not sufficiently retentive of moisture for successful dry-land farming.

Bainville silty clay loam.—Bainville silty clay loam is a shallow immature soil formed from shales that generally contain much silt and very fine sand. As developed elsewhere, the Bainville soils cover ridges and hillsides of different degrees of slope and have variable profiles. In this area, Bainville silty clay loam occupies a few small bodies on the lower slopes northeast of Forsyth where the thickness of the soil layer has been increased by colluvial-alluvial material washed from higher land. The upper 3-inch layer is dark grayish-brown fine-granular noncalcareous silty clay loam. Below this and continuing to a depth of 10 or 15 inches, the soil is brown massive calcareous silty clay, which in many places contains numerous salt crystals. This layer rests on yellow calcareous silty clay loam or directly on the partly weathered shale. The area in sec. 6, T. 6 N., R. 42 E., has an unusually thick layer of soil over the shale.

This soil is used only for grazing and has little agricultural importance. Livestock raising, which had its beginning near the forts and trading posts, is an important enterprise on this land.

MISCELLANEOUS SOILS AND LAND TYPES

In this group are included soil materials that are largely untillable.

Rough broken land.—The steeply eroded breaks bordering the small streams that enter the Yellowstone Valley and the eroded breaks or escarpments flanking this valley are designated as rough broken land (pl. 2). This category comprises three classes of soil materials—gravel deposits at the borders of some of the benches, thin soils over eroded and partly weathered sandstone material, and thin soils over eroded and partly weathered shale. Some included areas are bare of soil, and in places cliffs and sandstone stand out prominently. Northwest of Forsyth and north of Hysham, the Bearpaw shale formation outcrops over areas of considerable size.

In general, the vegetative cover is thinner on soils over the eroded shale areas than on the soils of the eroded sandstone-shale strata of the Lance formation. Scrub pines are scattered over some of the sandstone breaks. The land is used only for grazing.

Riverwash.—As mapped along the Yellowstone River and smaller streams, riverwash designates the unmodified incoherent gravels and sands forming river bars or low tracts that are periodically overflowed by high waters. The material in most places is devoid of vegetation, but here and there it supports a scattered growth of brush or willows (pl. 1, *A*). None of it is cultivated, and at present it is used only for the scant pasturage provided.

Colluvial soils, undifferentiated.—The designation of colluvial soils, undifferentiated, is given to extremely variable and decidedly immature soils originating from miscellaneous sands and gravels deposited by waters from the adjacent uplands. The material is coarse and very porous, and drainage is excessive. The position is ordinarily fanlike. Because of the low capacity to hold water and lack of organic matter, dry farming is not feasible on this land, and even under irrigation the land value would be low.

Alluvial soils, undifferentiated.—Alluvial soils, undifferentiated, include undeveloped, poorly drained clays or loams on the first bottoms, which occupy depressions and have developed little or no profile. The vegetation is commonly either saltgrass or cattail. The areas are small and scattered.

LAND USES AND AGRICULTURAL METHODS

WATER SUPPLY AND IRRIGATION

The middle Yellowstone Valley area, which extends through Treasure, Rosebud, and Custer Counties, includes five organized irrigation projects that are active throughout the summer and obtain water directly or indirectly from the Yellowstone River. The North Sanders and Buffalo Rapids projects are so located that it is impossible for them to take water from the river by gravity except during high-water stages. Either submerged dams in the river or low-lift pumps are necessary to obtain water during the main irrigation season.

Private pumping systems irrigate areas ranging in size from 50 to 1,200 acres. The United States Range Livestock Experiment Station near Miles City and the Sheffield farm near Sheffield have

the largest such systems. Other pumping projects are being proposed.

Although water in the Yellowstone River has always been plentiful, it cannot be diverted from the river during the late summer when the flow is lowest. Most of the gravity ditches were built too high to take water when the river was at its lowest stages, consequently it was necessary to throw dams across the river to raise the water level at the points of diversion. The Hammond and Box Elder districts maintain pumping plants, the former pumping directly from the river and the latter pumping from the Yellowstone district canal.

The Tongue-Yellowstone project diverts its waters from the Tongue River south of Miles City. The water supply in the latter part of the irrigation season occasionally has been short, but when the dam now in the process of construction is completed, this trouble should be lessened. Improved methods of irrigation would conserve considerable water as well as eliminate some unnecessary waste and seepage.

On a large number of farms throughout the valley the land must be leveled and the farm laterals relocated if the most efficient use is to be made of the available water. These improvements would also reduce the time and labor necessary to irrigate the land and would decrease the amount of seepage and accumulation of salts.

AGRICULTURAL METHODS AND MANAGEMENT

Because of the normal low precipitation, the diversified agriculture of the area is confined to the irrigated parts. Production in the nonirrigated parts is limited largely to small grains, corn, and native grasses.

Definite rotations have not been established everywhere, but since the introduction of sugar beets, a more systematic cropping plan has proved desirable. It is now generally agreed that a proper system of rotation should be followed—one that would distribute labor, maintain soil fertility, and take care of weeds. A combination of crops that can be worked into a rotation recommended for a farm of 80 acres or more is: Alfalfa grown on 25 percent of the land; sugar beets on 20 percent; feed grains on 10 percent; permanent pasture on 8 to 12 percent, depending on the need; and such other crops as may be desired on the rest. A rotation that has proved practicable on many farms in this area is as follows: Alfalfa, 5 to 7 years; beans, corn, or potatoes, 1 year; sugar beets, 2 years; and barley, wheat, or oats, 1 year.[7]

Changes in price levels for the various crops during the last few years have brought about a considerable increase in the acreage of sugar beets as compared with the acreage of alfalfa. This relative increase in the acreage of sugar beets may deplete the fertility and result in low yields unless it is accompanied by the use of considerable quantities of phosphate fertilizers and the application of barnyard manures obtained through feeding operations.[8]

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[7] For recommendations regarding crop varieties, the local county extension agent or the Agronomy Department of the Montana Agricultural Experiment Station may be consulted.

[8] NYGARD, IVER J. PHOSPHATE DEFICIENCY IN THE SOILS OF MONTANA: A PRELIMINARY REPORT. Mont. Agr. Expt. Sta. Bul. 240, 32 pp., illus. 1931.

——— A PROGRESS REPORT ON THE PHOSPHATE DEFICIENCY OF MONTANA SOILS. Mont. Agr. Expt. Sta. Bul. 259, 27 pp., illus. 1932.

In the nonirrigated tillable areas, the production of small grains (wheat, oats, or barley) probably will continue to be of importance. According to the more recent experiences of individual farmers, tillage practices, particularly the thoroughness and the regularity of summer fallowing, depend to a considerable degree on the location and character of the various soil types. Small benefit can be derived from the best summer-fallow practices on soils with the more open sandy or gravelly subsoils, because of their inability to store much moisture; but on soils that have silty or silty clay subsoils the chances of larger crops from good farm practices are much better. When the natural precipitation is extremely low, the most careful cultural methods do not prevent crop failures, particularly on the lighter textured soils. It has been shown in the better areas that, as a rule, fallowed land produces larger yields of wheat with a higher protein content [9] than land cropped continuously. Depletion of nitrogen in the soil should be guarded against by growing leguminous crops wherever possible and returning the crop residues to the land. The application of nitrogenous commercial fertilizers is a further means of restoring or increasing the supply of nitrogen in the soil.

MORPHOLOGY AND GENESIS OF SOILS

The factors of soil formation, as determined by the geographic environment, do not differ sufficiently over different parts of this area to produce marked differences in the soils. The area lies in the region of Chestnut soils. In general, the more mature soils are darker colored at the lower end of the area than at the upper end.

The middle Yellowstone Valley area lies a considerable distance west of the belt of Chernozem soils, where the soils attain the maximum blackness for well-drained soils. The moderately low rainfall has prevented the accumulation of a large quantity of organic matter. The precipitation is insufficient to leach the soluble salts to as great a depth as in the region of Chernozem soils. As a result, the soils in this area are dark grayish brown or brown, the humous layers are thinner, and the layer of calcium carbonate accumulation is nearer the surface.

The principal differences in the soils of this area are due, therefore, to differences in the character of the parent materials. The geologic materials that contribute to the soils are the alternating beds of sandstone and shale of the Lance and Judith River formations and the shales of the Bearpaw formation. The influence of the Judith River formation is very limited, as it outcrops in only one small tract at the western edge of Rosebud County. Material from the Bearpaw shale reworked by streams has produced extremely heavy saline soils, whereas the material from the Lance sandstones and shales has invariably resulted in more porous and lighter textured soils. Material from the Bearpaw shale contains considerably less lime than the material of the Lance formation. The shales of the Lance formation are gray or drab, whereas the shales of the Bearpaw formation are very dark gray, olive drab, or black. The colors of these parent materials persist in most of the soils.

[9] BURKE, EDMUND, and PINCKNEY, REUBEN M. THE INFLUENCE OF FALLOW ON YIELD AND PROTEIN CONTENT OF WHEAT. Mont. Agr. Expt. Sta. Bul. 222, 19 pp., illus. 1929.

The survey of this area is concerned chiefly with the alluvial flood plains and lower terraces, which are watered by irrigation projects. In order to bound the area by straight lines, however, in places upland slopes and parts of the higher benches are included. Some of the soils of the terraces have been exposed to the soil-forming processes a sufficient length of time to acquire the regional profile, but this profile does not exist in the soils of the flood plains because they are relatively very young. Where the alluvium consists of either gravel or heavy sediments, it has resisted the soil-forming agencies, and lack of drainage in some places has retarded development in such measure that no real soil profile exists. In some areas soluble salts strongly influence the character of the soil even at the surface.

The soils that have attained an approximation of the regional profile occur in the comparatively small areas of smooth high benches, which were capped in later Tertiary times. Undisturbed grassed-over areas have a loose mulch covering, 1 or 2 inches thick, of light-brown material. The organic horizon, which is 4 or 5 inches thick, is moderately dark grayish brown and generally somewhat laminated and granular. This is underlain, to a depth of 10 or 12 inches, by rich-brown generally heavier textured and more compact material with a definitely prismatic structure in most places. As a rule, the zone of calcium carbonate accumulation, which is 10 or 12 inches thick, lies immediately below the prismatic layer. The material of this zone is, for the most part, loose, structureless, light grayish brown or yellowish brown, lighter in texture, and more friable than that in the layer above. Below the calcium carbonate zone, sand and gravel strata are typical of some of the benchland, but in other places this layer is brown silt loam or very fine sand. The general profile described is representative of the soils of the Beaverton and Farland series.

Most of the soils in the area are intrazonal, and their characteristics are largely dominated by the parent material. Such soils are grouped in the Patent, Huff, and Bainville series. The Patent soils are dark gray in color and heavy in texture. Their thin surface soils are underlain by heavy intractable clays. These soils are developed over heavy clays, which are derived from nearby shales. The Huff soils are grayish brown or brownish gray, friable, and generally porous. They are formed over alluvial material washed from adjacent uplands.

The Bainville and the Flasher soils are developing from the disintegration of the sandstone and shales in place. They have thin dark grayish-brown calcareous surface layers with little or no profile or structural development in the lower part of the profile.

The soils of the flood plains of the Yellowstone River are members of four series, namely, Havre, Harlem, Banks, and Bowdoin. These soils owe their distinguishing characteristics mainly to the influence of their parent materials, because soil development is not very advanced. The Banks soils have brown sandy surface soils, and their subsoils are loose incoherent sands. The moderately dark brown surface layers of the Havre soils range from very fine sandy loam to silty clay loam, and the subsoils from fine sand or very fine sand to very fine sandy loam. The Harlem soils have dark-colored heavy surface soils over light-colored light-textured subsoils. Dark-gray surface soils and extremely heavy dark olive-gray subsoils characterize the soils of

the Bowdoin series. Most areas having a high water table or those subject to seepage are alkaline.

SUMMARY

The middle Yellowstone Valley area has a continental climate characterized by a moderately low annual precipitation, a dry atmosphere, hot summers, cold winters, and a large proportion of sunshiny days. For the production of diversified crops and maximum yields, irrigation is necessary to supplement the natural rainfall during summer. Small grains may be grown in most seasons, under good dry-land farming methods.

In general, the area that the Yellowstone Valley dissects may be characterized as a rolling plain sloping toward the east. The river has cut its valley in successive stages, so that in places distinct benches or terraces remain as evidence of former alluvial plains. In places, two or three series of benches rise above the present river valley.

Diversified and intensive cropping in this area is dependent on a supply of irrigation water. The dominant crops are sugar beets and alfalfa. Alfalfa is the basic crop for this area. It is naturally adapted to the high-lime soils, assists in the maintenance of the nitrogen content of the soils, and is a primary feed crop. Feed crops, such as corn, oats, or barley are grown on a small acreage, according to the needs of the individual farmer. Wheat is grown on the irrigated land, but to much less extent than formerly. The maintenance of soil fertility under intensive cropping depends to a considerable degree upon establishing sound cropping systems or rotations and the return to the lands of barnyard manure and crop residues.

Dry farming is carried on in the nonirrigated areas. The method of farming practiced is the alternate small-grain and fallow system.

Livestock have an important part in the agricultural industry of the area. Bordering the Yellowstone Valley are large areas of land unsuited for tillage but well suited for grazing.

The soils of the valley bottoms are, for the most part, well drained and porous, particularly the Havre soils. Under irrigation, the Havre soils are suited for diversified cropping. Although their natural content of organic matter is low, it is increased easily by growing legume crops and by returning manures and crop residues to the soil. The Bowdoin soils are restricted somewhat in crop adaptations because of their heavy texture and poor natural drainage. The other soils in this group are members of the Harlem and the Banks series.

Where the soils of the valley benches and gentle slopes are sufficiently thick over the gravel substrata and have a medium texture, they are suited to dry farming. The benchland soils that may be irrigated are well suited to a diversified cropping system. These soils are members of the Beaverton and Farland series. The heavy Patent soils are developing on gentle slopes from heavy material that contains soluble salts. Owing to their heavy texture, they are used for grazing.

The Bainville and the Flasher soils of the eroded slopes have porous and almost structureless profiles. Their capacity for storage of subsoil moisture is less than that of the better developed soils, and they are less adapted to dry-land farming.

The miscellaneous soils and land types (which include rough broken land; alluvial soils, undifferentiated; riverwash; and colluvial soils, undifferentiated) are used only for grazing.

Most of the soils in the area are comparatively young. Their immaturity is shown by their profiles, which lack clearly defined layers, or horizons, which develop with leaching and age. The soils are practically unleached; that is, few soluble materials have been moved to lower depths, because the rainfall is low and the periods of leaching are short. Two of the more mature soils have zones of calcium carbonate accumulation. The soils are generally high in lime and low in organic matter. Deficiency of available phosphorus is indicated in a few places by response to applications of superphosphate to land for sugar beets. The soils of the area have developed under a short-grass cover of less dense growth than that on the areas farther east. The well-developed or mature soils occupy the high benches.

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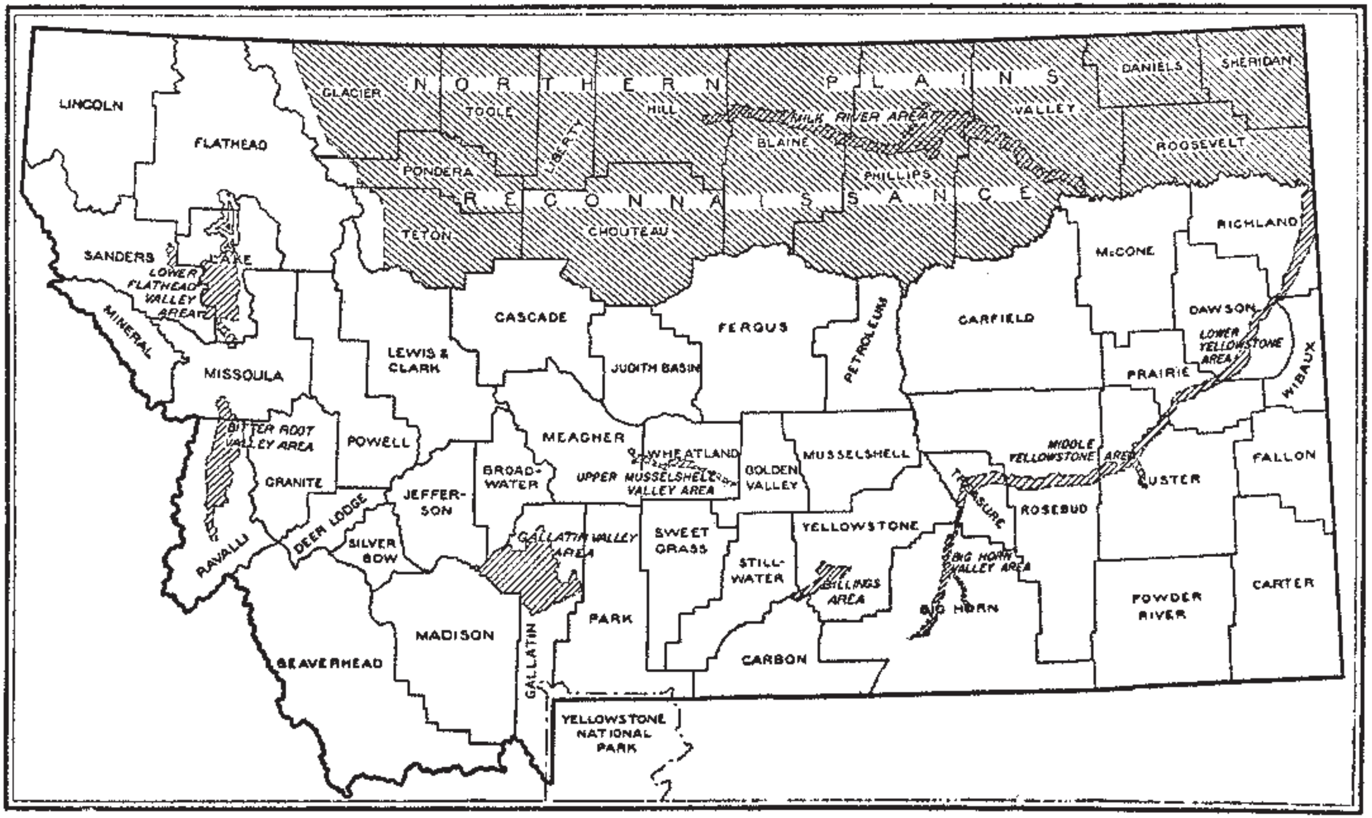

Areas surveyed in Montana shown by shading.

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SOIL SURVEY DIVISION, CHARLES E. KELLOGG, CHIEF

SOIL MAP
MIDDLE YELLOWSTONE VALLEY AREA
MONTANA

MONTANA AGRICULTURAL EXPERIMENT STATION
F. B. LINFIELD, DIRECTOR
WILLIAM DEYOUNG, IN CHARGE DETAIL SURVEYS

Thomas D. Rice, Inspector, District 3.
Soils surveyed by William DeYoung, in charge, and F. K. Nunns, Montana Agricultural Experiment Station, and L. H. Smith, U. S. Department of Agriculture.

LITHO EASTERN OFFSET INC., BALTO.

Scale 1 inch-2 miles

2 1½ 1 ½ 0 2 4 6 Miles

DIAGRAM OF TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

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